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Malacological associations from the marine reserve of S. Maria di Castellabate (southern Tyrrhenian sea): multivariate analysis and cartographic representation by the Kriging interpolation technique

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KEY WORDS: Marine reserves, Mollusc communities, Guilds, Multivariate analysis, Kriging.

ABSTRACT A formal procedure that allows the identification of mollusc community structures and the spatial patterns associated with them in the area of the marine park of S. Maria di Castellabate was tested. A set of qualitative data from the literature was transformed and reorganized in such a way as to become robwt enough to undergo statistical treatment.

Significant community patterns were recognized which, on one hand, provideinformation on the bionomic features and, on the other, allow the description in functional terms of the associations as the products of the integrated action of the main dynamic and hydrological characteristics.

This analytical procedure was shown to be effective for utilizing, in synecological analyses, information which was originally collected for different purposes, as is the case for most conchological collections.

RIASSUNTO Nel presente lavoro vengono presentati i risultati della sperimentazione di una procedura di analisi che potrebbe consentire una lettura 'formale' di dati provenienti da raccolte qualitative e da meri elenchi faunistici.

Per l'analisi sono stati considerati dati malacologici provenienti da raccolte subacquee effettuate con metodiche molto diverse nell'area del Parco marino di S. Maria di Castellabate (Salerno), all'epoca della sua istituzione (nei primi anni '70). L'area era stara suddivisa in 31 settori per ognuno dei quali era stato fornito un elenco faunistico con indicazioni qualitative dell'abbondanza delle specie e dell'intervallo batimetrico in cui erano state rinvenute. I settori sono stati raggruppati in 4 sub-aree, ciascuna alquanto omogenea al suo interno per fisionomia della linea di costa e del substrato marino antistante. Nel presente studio sono state considerate le due sub-aree più meridionali, quella di Vallone Alto (dal porto di S. Marco di Castellabate a Punta Licosa), comprendente 7 settori, e quella di Licosa (dalla punta omonima alla Baia di Ogliastro Marina), comprendente 9 settori. Ogni settore è stato assimilato ad un transetto costa-largo di stazioni arbitrariamente fissate alle profondità di 0, 5, 10, 20, 30 e 40 m. Le associazione malacologiche presenti in queste stazioni sono state definite in base agli intervalli batimetrici riportati, per ciascuna delle specie, nell'elenco faunistico qualitativo. Le indicazioni qualitative di abbondanza delle specie (rara, scarsa, comune, abbondante) sono state convertite in ranghi numerici. La matrice di rango così ottenuta è stata trattata con tecniche di analisi multivariata per ottenere modelli di ordinamento che consentissero di evidenziare le principali tipologie strutturali e funzionali delle associazioni malacologiche presenti nell'area. Sono stati utilizzati tre differenti tipi di descrittori: tassonomici, trofici e bionomici. Questi sono stati ottenuti raggruppando gli individui rispettivamente in base alla loro affinità tassonomica a livello di specie; alla affinità di alimentazione ed alla affinità di ambiente di appartenenza. L'analisi spaziale delle diverse tipologie cenotiche presenti nelle sub-aree in esame è stata ottenuta con la tecnica di interpolazione su mappa denominata *kriging*, utilizzando i valori delle saturazioni sugli assi dei punti-stazione nei modelli di ordinamento. Oltre alla classica zonazione con la profondità dei popolamenti malacologici, nell'analisi sono emersi 'gradienti laterali' che rivelano discontinuità cenotiche tra i diversi settori, soprattutto nei livelli più profondi. Un interessante relazione tra tipologie geomorfologiche e cenotiche è stata evidenziata nel settore più meridionale di Vallone Alto, ove la risalita della soglia del bassofondo di Licosa è marcata da un ripidissimo cenoclino malacologico, che comprende un drastico cambiamento delle tipologie alimentari dominanti. I risultati ottenuti, consentendo una efficace capacità analirica delle tipologie cenotiche ed una resriruzione grafica di immediata lettura, confermano, da un lato, l'efficienza della procedura di organizzazione e di elaborazione formale adottata nel recupero di dati raccolti qualitativamente e, dall'altro, la robustezza e l'affidabilità del taxocene a molluschi per analisi interpretative dell'ambiente marino su larga scala quali, ad esempio, quelle necessarie per gli studi di fattibilità delle aree protette.

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INTRODUCTION

Mollusc communities are among the best descriptors of littoral benthic systems (GAMBI *et al.*, 1982), as they integrate the environmental variability well thanks to their species richness (the result of wide adaptive radiation) and the heterogeneity of their assemblages. Therefore, their structural and spatial patterns can be utilized successfully to characterize coastal areas in terms of biodiversity and habitat heterogeneity, as in the case of planned marine reserves.

In spite of the considerable collecting activity carried out by malacologists, quantitative data obtained by standardized sampling and sorting procedures,which allow the use of a mathematical approach in the inference of community traits are quite rare in the literature. Most of the information is confined to species lists, at best accompanied by broad indications, sampling depth and, sometimes, qualitative estimates of species abundance (i.e. rare, common, abundant, etc.). One of the main problems when dealing with such inadequate qualitative information is the difficulty of assembling and comparing sets of data to allow the evaluation of molluscan community structures and, hence, associated ecological patterns.

A paper by OTERO (1985), which contains the most complete malacological list available for the marine reserve of S. Maria di Castellabate, represents a typical example of a considerable sam-

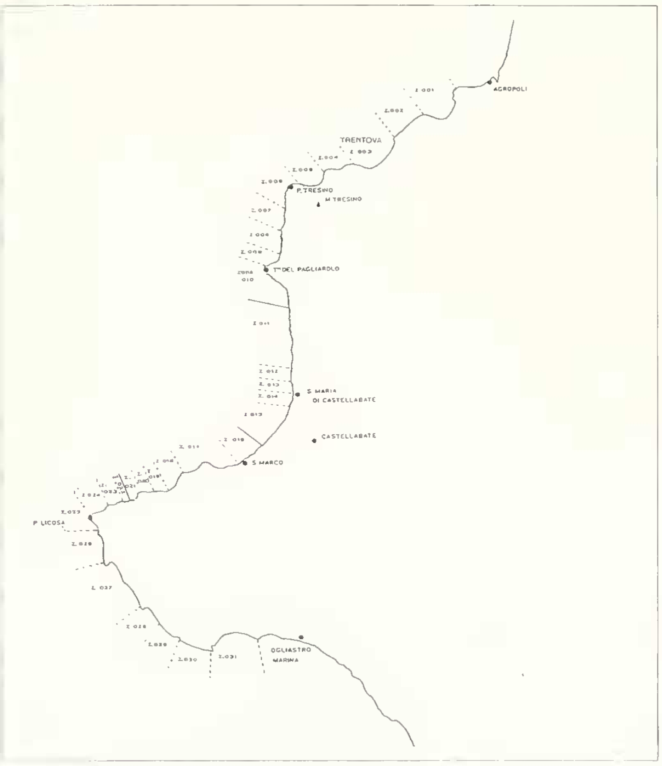

Figure 1. Map of the Marine Park of S. Maria di Castellabate with the subdivision in 31 sectors (after OTERO, 1985).

pling effort merely resulting in a qualitative set of data. The information contained in the paper of OTERO is utilized were in an attempt to set up a formal procedure which allows the identification of molluscan community structures and the spatial patterns generated by them. Qualitative data were transformed and reorganized into a set robust enough for statistical treatment so as to reveal recognizable and significant community patterns.

MATERIALS AND METHODS

Site and sampling procedures

The marine reserve of S. Maria di Castellabate is one of the earliest established in Italy (Ministerial Decree, August 25 1972), and has recently been included in the list of national marine parks (Law n. 394, 1991). It covers the southernmost coastal area of the Gulf of Salerno, in the region of Cilento (southern Tyrrhenian coast), where a terrestrial national park has also recently been established (RUSSO & SGROSSO, 1995).

Since the institution of the marine reserve, some floristic and faunistic studies have been carried out, including a malacological one, assembled and published several years later by OTERO (1985). The author divided the reserve into 31 arbitrarily-chosen sectors, from the Cape of Agropoli to the Bay of Ogliastro Marina (Fig. 1), collecting with different sampling procedures in each sector. The shallow malacofauna (0-12 m) was mostly sampled by snorkelling, while the deeper malacofauna (12-40 m) was collected by picking up specimens trapped in fishing nets and by washing the algal tufts and seagrass leaves collected by SCUBA divers. Dredging was also used on soft bottoms to a depth of 60 m.

This activity generated a list of 279 taxa at the species or sub-species level, including for each taxon the sector and depth of collection, the overall depth range (e. g. 0-5 m; 10-45 m; 40-60 m) and the presence rank (RR= extremely rare; R= rare; S= scarce; C= common; A= abundant).

Organization of data

In the present work, 16 of the 31 sectors were taken into account, covering the area from the port of S. Marco to the bay of Ogliastro Marina (sectors Z.016-031 in Fig. 1). Each sector was considered as a depth-transect, along which six formal stations of 1, 5, 10, 20, 30 and 40 m were located. For each station, a list of species (present within the sector and the depth range) was compiled.

Species names were updated according to the recent nomenclature (SABELLI *et. al.*, 1990). All sub-species or varieties were grouped into the species taxon. To each species, the following numerical ranks were assigned on the basis of the qualitative code of abundance used by OTERO (1985): RR=1; R and S = 2; C=3; A= 4.

The numerical data set was arranged at first in a matrix of ranks with dimensions which proved too large to be dealt with on a personal computer, and was therefore split into two subsets which included sectors Z.16-22 (called Vallone Alto) and Z.23-31 (called Licosa). The 131 species x 42 stations (6 depths x 7 transects) rank matrix of Vallone Alto and the 91 species x 54 stations (6 depths x 9 transects) rank matrix of Licosa were therefore utilized in the multivariate analysis. In these matrices, all the species whose total for each row was 1 or 2 (very rare in one or two stations; rare or scarce in only one station) were excluded in order to avoid distortion in the structure of the data (PIELOU, 1977).

Considering the species from the point of view of their feeding habits, as proposed by STENEK & WATLING (1982), PUR-

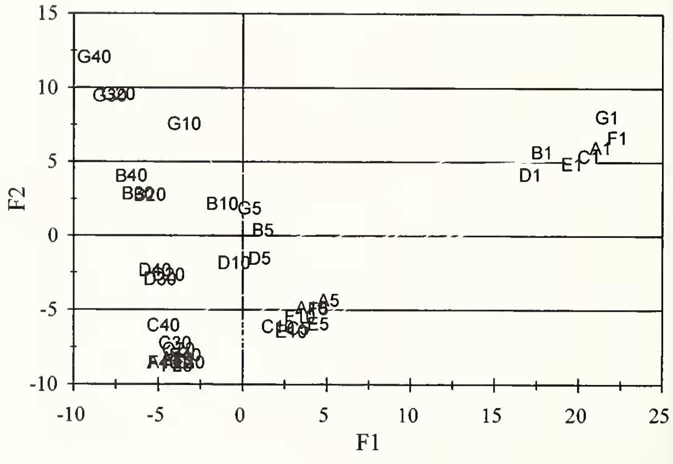

Figure 2. VALLONE ALTO, AC ordination model (F1-F2) of station-points (in the labels, letters indicate transects, numbers are referred to depth): matrix of taxonomic descriptors.

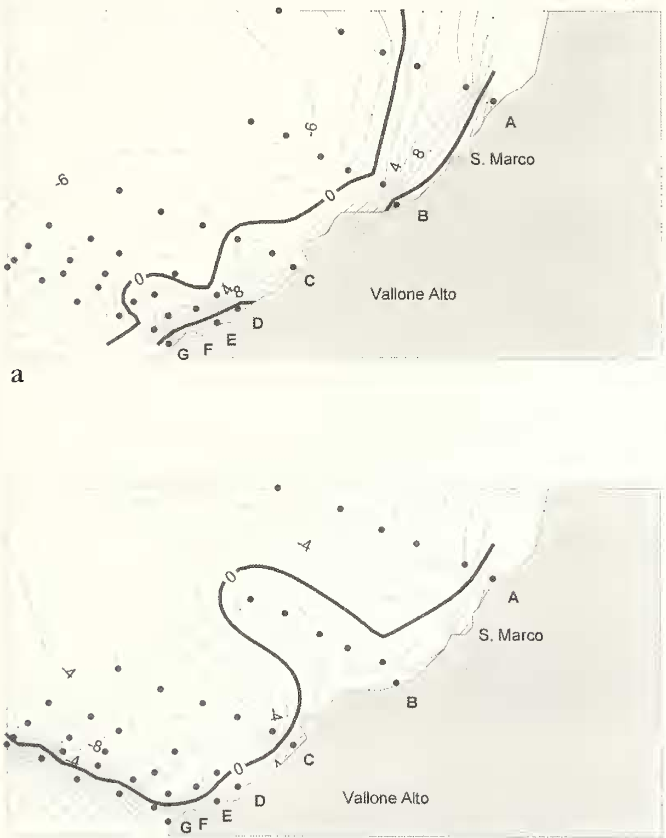

Figure 3. VALLONE ALTO, kriging maps: scores of taxonomic descriptors on F1 (a) and on F2 (b).
Transects from A to G correspond to sectors from Z.016 to Z.022.

CHON (1977) and BARNES *et al.* (1988), the following 10 trophic guilds were identified: herbivore brusher (HBR); herbivore scraper (HSC); herbivore rasper (HRA); herbivore-deposit feeder (HDF); herbivore cutter (HCU); benthic hunter (BH); deposit feeder (DF); suspension feeder (SF); feeder on colonial sessile animals (FCSA); commensal (C).

In order to set up the 10 (guilds) x 42 (stations) functional matrix of Vallone Alto and the 10 (guilds) x 54 (stations) functional matrix of Licosa, the number of species belonging to each functional guild was calculated on the basis of the presence/absence data matrix (species x stations).

Considering the distribution of the species in accordance with the model of PERES & PICARD (1964), the following 9 bionomic units were identified: photophilic algae (AP); *Posidonia* seagrass beds (HP); sciaphilic or 'coralligen' (C); fine sand on shallow bottoms (SFHN); well-sorted fine sand (SFBC); muddy sand of sheltered environments (SVMC); coastal terrigenous mud (VTC); muddy detritus (DE); coarse sand under the effect of bottom currents (SGCF). Starting from the presence/absence data matrix (species x stations), the number of species 'characteristic' (*sensu* PÉRÈS & PICARD, 1964) of each of the above bionomic units was calculated for the stations in order to generate the bionomic matrices of Vallone Alto (9 units x 42 stations) and of Licosa (9 units x 54 stations).

Analysis of data

The six data matrices were utilized as the bases for the ordination models obtained by Correspondence Analysis (CA) (PIELOU, 1984). Six ordination models were generated, utilizing three different types of descriptors (taxonomic, trophic, and bionomic) for each of the two areas (Vallone Alto and Licosa). The significance of the factors was tested according to the method proposed by FRONTIER (1974).

The factor scores (three at the most) of the station points, which can be considered as synthetic variables of the different coenotic patterns, were then utilized for *kriging*, a cartographic method which uses stochastic interpolation techniques (CRESSIE, 1991).

Kriging is a very flexible method and is useful for interpolating almost any type of data set. A total of 1000 interpolating values, arranged on 20 x 50 rectangular grids, with their longest side almost parallel to the coastline, were utilized (mesh size of about 110 m). The known values were 42 (Vallone) and 54 (Licosa) respectively, so that 5% of the grid points were interpolated. The maps were drawn using the best-fitting surface, i.e. a quadrant and a linear variogram. Eighteen isoline maps were obtained from the F1, F2 and F3 scores of each of the six ordination models.

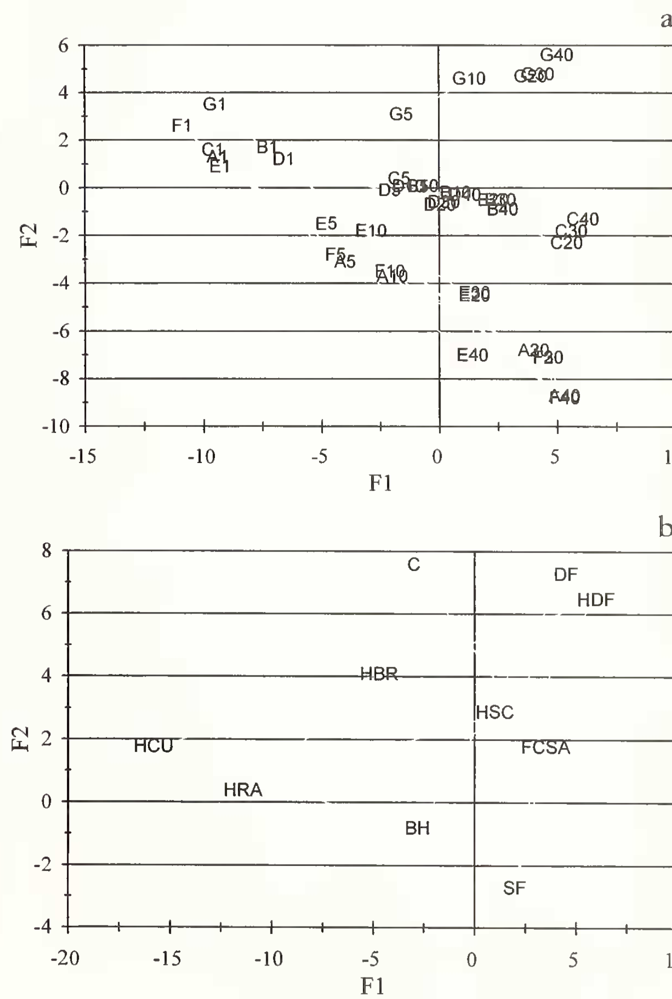

Figure 4. VALLONE ALTO, AC ordination models (F1-F2) of descriptor-points (a) and of station-points (b): matrix of trophic descriptors.

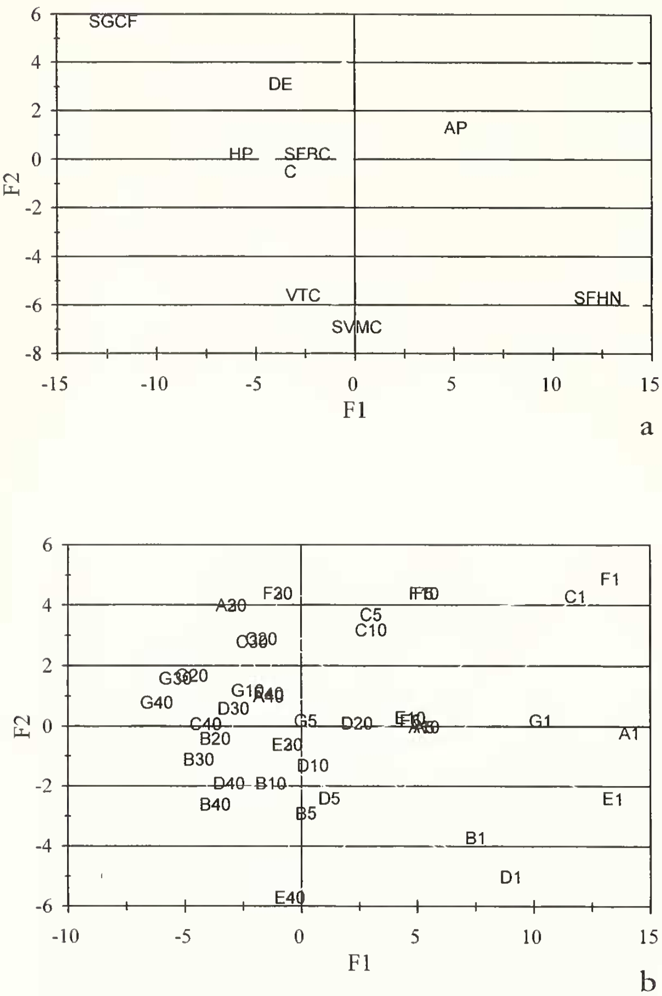

Figure 5. VALLONE ALTO, AC ordination models (F1-F2) of descriptor-points (a) and of station-points (b): matrix of bionomic descriptors.

RESULTS

1) Vallone Alto

a) Taxonomic descriptors

In the AC ordination model, obtained from the rank matrix of taxonomic descriptors (Fig. 2), the first three factors are significant (F1= 23.0%; F2= 14.3%; F3= 11.3% of the total variance). Along the first axis, the station points are displayed according to their depth. The shallow stations are polarized in the positive side of the axis, those of the intermediate depth levels (5-10 m) are distributed close to the origin of the axes, the deep ones (20-40 m) have negative scores. Along the second axis, the station points belonging to the same transect have similar scores. Although transects are displayed at different levels of polarization, clearer discontinuities among the deep stations are shown. A similar pattern is expressed by the third factor.

The cartographic representation of the pattern expressed by the first factor (Fig. 3a) shows isolines parallel to the coastline, marking changes in the coenotic structures that occur at well-defined critical depths along the transects. A high contiguity of isolines and an isoline pattern which is oriented differently is, however, evident in the area near Punta Licosa (transects E-G).

In the maps interpolating the scores of the stations related to the second (Fig. 3b) and third factors, the isolines are nearly perpendicular to the coastline, indicating the co-occurence of 'lateral gradients', the result of coenotic changes in stations with similar depths. Once again, the high contiguity of isolines in the area near Punta Licosa (ttansects E-G) is evident.

b) Trophic descriptors

The AC ordination model obtained from the matrix of trophic descriptors (Figs. 4a, 4b) has three significant axes (F1= 42.4%, F2= 30.2% and F3= 11.0% of the total variance). The station points are distributed along the first factor consistent with their depth, the shallow stations have negative scores and are opposed to the deep ones (positive scores), with the intermediate ones in the middle, close to the origin of the axes. It is worth noting how different types of herbivore guilds characterize the levels of the transects: HCU and HRA are associated with the shallow stations, HBR and HSC with the intermediate, and HDF with the deep ones. As for the other guilds, C and BH are related to the intermediate stations and DF, SF and FCSA to the deep stations. Along the second factor, the different transects are separated, particularly with regard to the deep stations. The opposi-

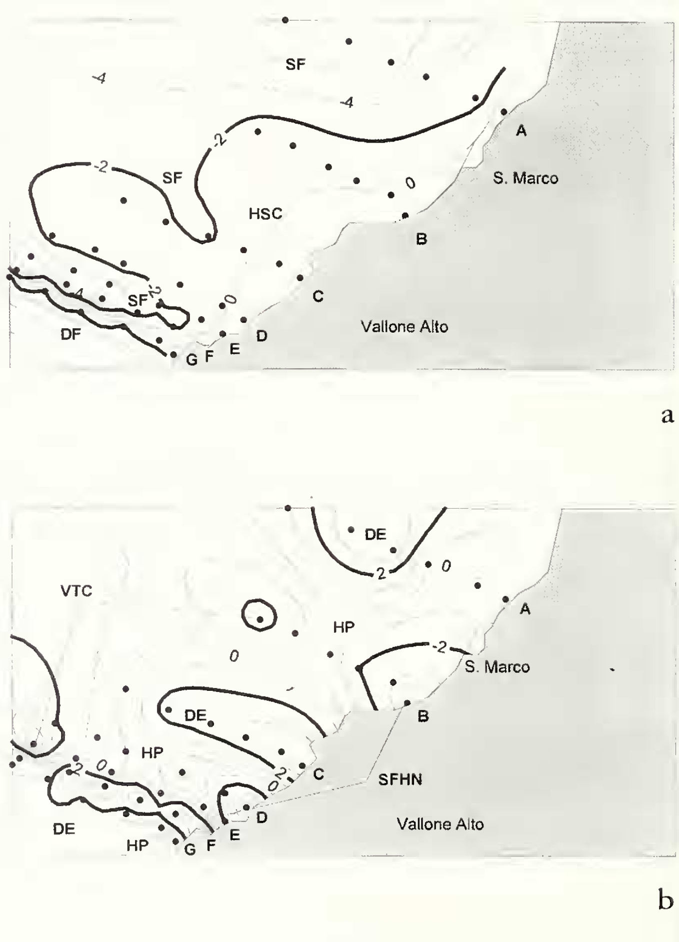

Figure 6. VALLONE ALTO, kriging maps: scores on F2 of trophic (a) and bionomic (b) descriptors.

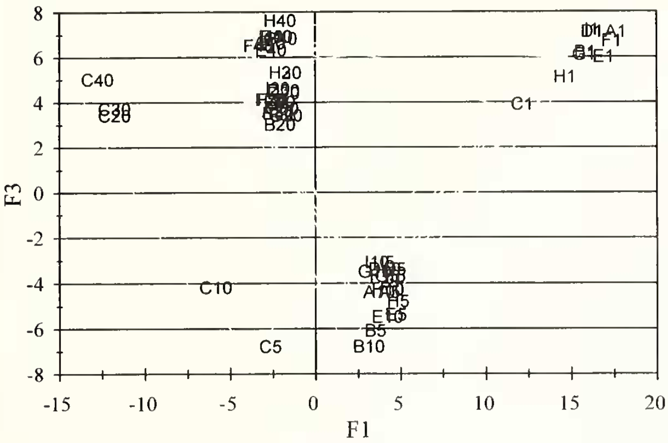

Figure 7. LICOSA, AC ordination model (F1-F3) of station-points: matrix of taxonomic descriptors.

tion between DF and HDF, on the positive portion of the axis, and SF, on the negative one, is evident. Deep stations (20-40 m) of transect G are polarized in the 'deposit feeder' factorial pole, the remaining stations in the 'suspension feeder'.

In the case of these descriptors the cartographic representation of the coenotic gradient expressed by the first factor also shows isolines parallel to the coastline, with a pattern similar to that shown in Fig. 3a. In the maps interpolating the scores of the stations related to the second (Fig. 6a) and the third factors, the isolines have a very low contiguity, indicating weak spatial gradients of trophic specialization within the associations. The area of punta Licosa appears to be an exception, with a very high contiguity of isolines, indicating a marked rearrangement in the trophic structure occurring in transect G, which is characterized by 'deposit feeders', with respect to the other transects which are characterized mainly by 'suspension feeders'.

c) Bionomic descriptors

In the AC ordination model, obtained from the matrix of bionomic descriptors (Figs. 5a, 5b), the first two factors are significant (F1= 60.1% and F2= 14.8% of the total variance). Along the first axis, the station points are displayed according to their depth. The shallow and intermediate stations (1-10 m) are polarized in the positive portion of the factor, while the deep ones (20-40 m) have negative scores. Along the second factor, transects are again displayed at different levels of polarization (transects A, C, F and G in the positive portion, and transects B, D and E in the negative), with more marked discontinuities among the deep stations.

It is interesting to note how different types of bionomic guilds characterize the levels of the transects: AP and SFHN are strongly associated with shallow stations, while the remaining bionomic units are associated with deeper levels. Along F2, where intermediate and deep stations are well spaced, three clusters of stations are associated with DE (in the positive portion), HP and C (close to the axis) and VTC (in the negative portion).

As for the previous descriptors (taxonomic and trophic), the cartographic representation of the pattern expressed by the first factor shows isolines parallel to the coastline, with the exception of the area by Punta Licosa. In the maps interpolating the scores of the stations related to the second factor (Fig. 6b), the isolines show a complex pattern with concentric distributions that enclose the whole transect. This pattern becames more evident in the area near Punta Licosa (transects F and G), marking a high bionomic variability.

2) Licosa

a) Taxonomic descriptors

In the AC ordination model obtained from the rank matrix of taxonomic descriptors (Fig. 7), the first three factors are significant (F1= 25.4%; F2= 21.5%; F3= 10.8% of the total variance). Along the first axis, the station points are displayed according to their depth. The shallow stations (1 m) are polarized in the positive portion of the factor, those of the intermediate depth levels (5-10 m) are distributed close to the origin of the axes and the deep ones (20-40 m) have negative scores. The same pattern is shown along the second axis. A particular trend is, however, associated with transect C, the only one completely polarized in the positive part of the factor. Along the third axis (displayed in figure 7), shallow and deep stations are opposed to the intermediate ones, grouped in the negative part.

The cartographic representation of the pattern expressed by the

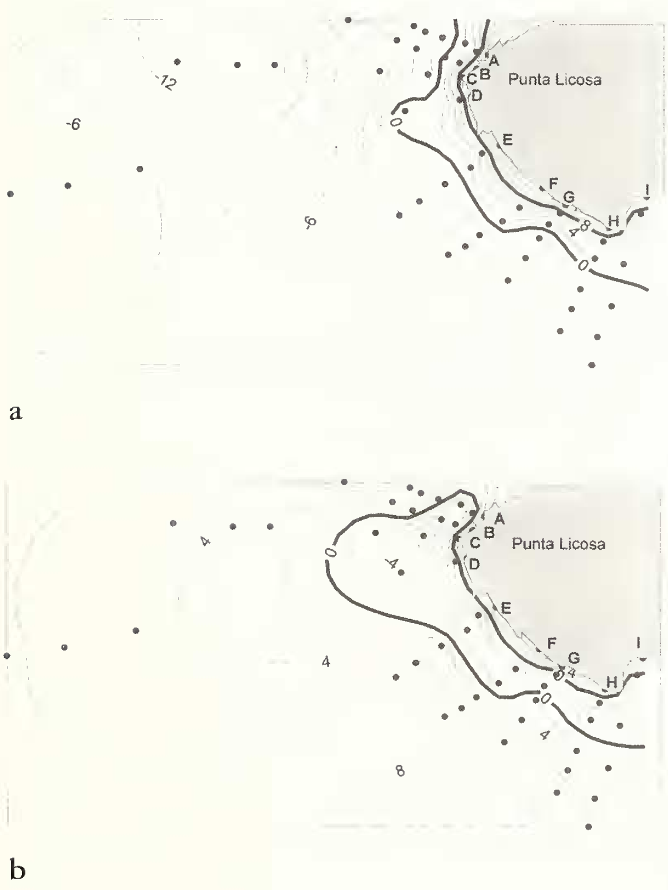

Figure 8. LICOSA, kriging maps: scores of taxonomic descriptors on F1 (a) and on F3 (b). Transects from A to I correspond to sectors from Z.023 to Z.031.

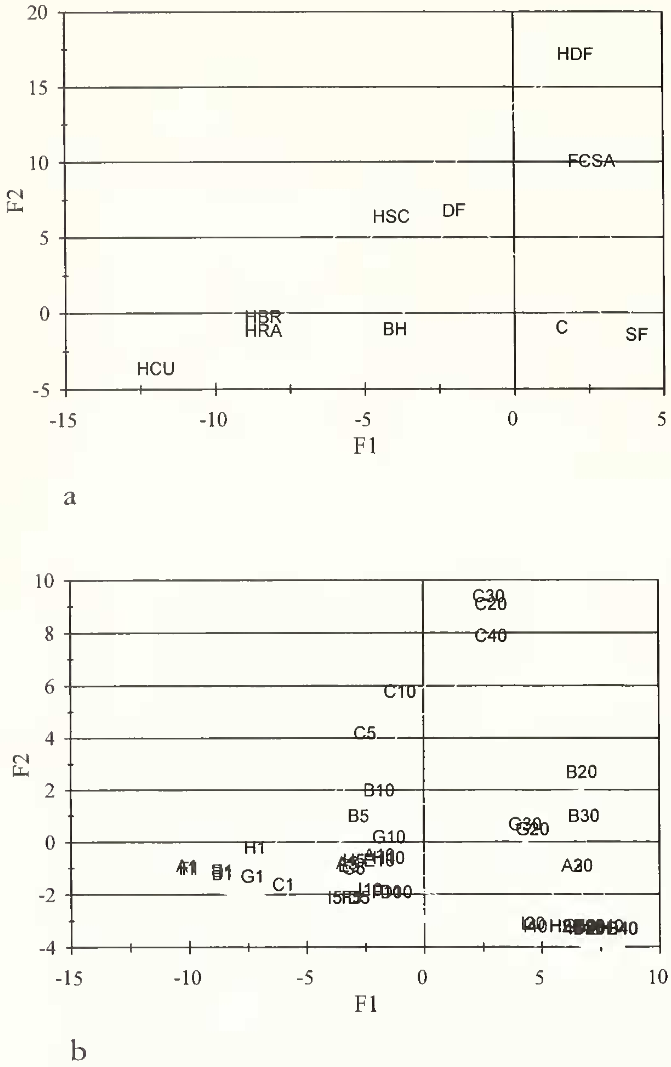

Figure 9. LICOSA, AC ordination models (F1-F2) of descriptor-points (a) and of station-points (b): matrix of trophic descriptors.

first factor (Fig. 8a), shows a remarkable coenotic homogeneity in the area between Punta Licosa and Ogliastro Marina (transects D-I), with a small number of widely-spaced isolines. The opposite pattern is present in the area facing Punta Licosa (transects A-C), where tightly spaced isolines, perpendicular to the coastline, are evident. This pattern indicates well the peculiarity of the coenotic structure occurring along transect C and the steep coenoclines connecting this particular transect with the adjacent ones. By mapping the scores of the second factor, a depth-related pattern becomes evident, with coenotic isolines tightly-spaced and parallel to the coastline throughout the area, except for the zone facing Punta Licosa. This zonal pattern is more evident when the map interpolating the scores of the stations related to the third factor is considered (Fig. 8b).

b) Trophic descriptors

The AC ordination model obtained from the matrix of trophic descriptors (Figs. 9a, 9b) has three significant axes (F1= 42.3%, F2= 27.1% and F3= 9.6% of the total variance). Again this model, the station points are distributed along the first factor consistent with their depth. The shallow stations have negative scores and are opposed to the deep ones (positive scores) with the intermediate stations in the middle, close to the origin of the axes. As in the area of Vallone Alto, it is interesting to note how the different types of herbivore guilds characterize the levels of the transects: HCU, HRA and HBR are associated with the shallow stations (1 m), HSC with the intermediate (5-10 m), and HDF with the deep stations (20-40 m). As for the other trophic guilds, DF and BH are related to the intermediate stations while C, SF and FCSA are related to the deep ones. Along the second factor the opposition between DF and HDF, in the positive part, and SF, in the negative, is evident. Transect C is the only completely clustered one in the positive portion of the factor.

The cartographic representation of the coenotic gradient expressed by the first factor shows isolines parallel to the coastline (Fig. 10). Also in the case of these descriptors, the area of Punta Licosa is the exception, with isolines oriented perpendicular to the coastline, describing a lateral coenotic gradient which develops from transect C to the adjacent transects. This pattern is clear and is basically reproposed by the maps interpolating the scores of the stations related to the second and the third factor.

c) Bionomic descriptors

In the AC ordination model obtained from the matrix of bionomic descriptors (Figs. 11a, 11b), the first three factors are significant (F1= 45.5%, F2= 22.6% and F3= 14.2% of the total variance). Along the first axis, the station points are displayed according to their depth. The shallow and intermediate stations (1-10 m) are polarized in the negative portion of the factor, while the deep stations (20-40 m) have positive scores.

As regards the displacement of the different types of bionomic guilds, along this factor AP, SFHN, SVMC and SFBC are associated with shallow and intermediate stations, while HP, C, VTC and DE are associated with deep levels.

Along the second factor, the oppositon of the bionomic unit SFHN (strongly polarized in the negative part) with respect to all the others has the effect of clusterizing all the points.

An interesting ordination is observed in the third axis (Figs. 11a, 11b),. Transects are displayed at different levels of polariza-

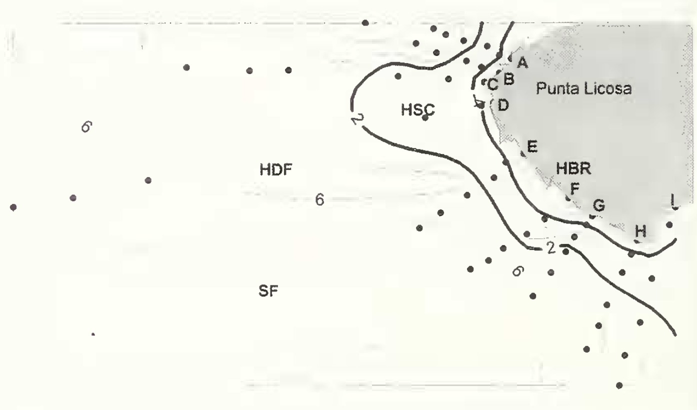

Figure 10. LICOSA, kriging map: scores on F1 of trophic descriptors.

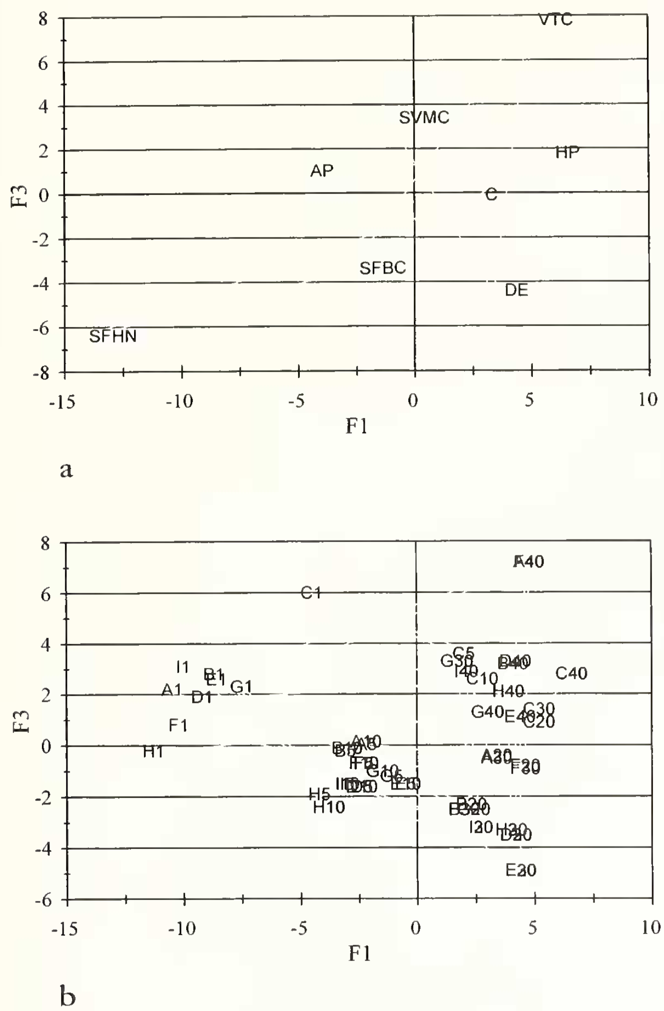

Figure 11. LICOSA, AC ordination models (F1-F3) of descriptor-points (a) and of station-points (b): matrix of bionomic descriptors.

tion, with more clear-cut discontinuities within deep stations. The deepest stations of transects A and F (40 m) are positively polarized and are associated with the VTC guild. Conversely, some of the deep stations (20-40 m) of transects B, D, E, G, H and I are associated with the DE guild in the negative part of the factor, the others being associated with HP or C in the intermediate part of the factor.

The cartographic representation of the pattern expressed by the first factor shows isolines parallel to the coastline (Fig. 12a). In the maps interpolating the scores of the stations related to the second and third factors (the latter in Fig. 12b), the isolines show a complex pattern with lateral gradients and concentric distributions enclosing different transects and stations. This pattern is particularly evident in the area near Punta Licosa (transect D), a probable indication of high bionomic variability.

DISCUSSION AND CONCLUSIONS

In ecological research it often proves useful to represent environmental variables on maps. As regards the marine environment, this manner of representation is widely applied to prepare maps where, for example, depths and bathimetric isolines are displayed. What may be of particular interest is the use of cartographic representation, not only for simple physical and chemical parameters (e.g. depth, temperature, salinity, nutrient concentration etc.), but also for biological (Scardi *et al.*, 1989) and community parameters (Scardi & Fresi, 1985; Scardi & Fresi, 1986).

When working with communities, the main problem is the selection of both descriptors and their synthetic variables, to allow the correct inference of ecological spatial patterns. Factor scores may represent a powerful synthetic variable of community descriptors, the most widely used of which are taxonomic ones (taxa at the species level). Apart from information provided on the community structure, based on the co-occurrence of species in stands, the functional aspects may also be viewed by considering life habits (e. g. feeding strategies, reproductive tactics, etc.). Therefore, these important elements, at the basis of the 'taxonomic organization' of communities, may be utilized as further descriptors of coenotic system organization, allowing the passage to be made from a descriptive (a ecology) to a causal (b ecology) analytical stage.

Additional complementary descriptors may be obtained by considering the association to which single species preferentially belong. In several malacological studies, such associations are utilized to infer bionomic information, assuming a straigthforward relationship between the species and their associations.

This allows the bionomic characterization of stations on the basis of their taxocoene. The theory behind this method is questionable. As most species may partecipate in different associations, it is unrealistic to assume a straightforward relationship between single species and single associations. This procedure has,however, been adopted in the present study, with interesting results.

The taxonomic, functional (trophic) and bionomic information obtained from the study of the malacological taxocoene living in the marine reserve of S. Maria di Castellabate gives a well-integrated picture of the main benthological features of the area. The ordinations and cartographic representations obtained starting from the different coenotic descriptors are consistent.

The main spatial patterns of the malacological assemblages are related to depth, which can be easily interpreted as the first factor of the ordination models, independently of the descriptors taken into account. Three depth-related zones, sequentially distributed from the coast to the open sea, may be recognized: the shallow zone (1m £ stands < 5m), the intermediate zone (5m £ stands £ 10m) and the deep zone (10m < stands £ 40m).

Hard substrate species of the mesolittoral and the upper infralittoral live in the shallow zone, which is restricted to a fringe which includes the first level of the transects. The malacological assemblage is functionally specialized in herbivory with high mechanical impact on the trophic substrate (cutters and raspers). The intermediate zone is mainly characterized by an association typical of hard bottoms covered by photophilic algae, specialized in herbivory with low impact on the trophic substrate (brushers and scrapers). This zone extends quite far from the coastline near Punta Licosa (transects C and D), mark-

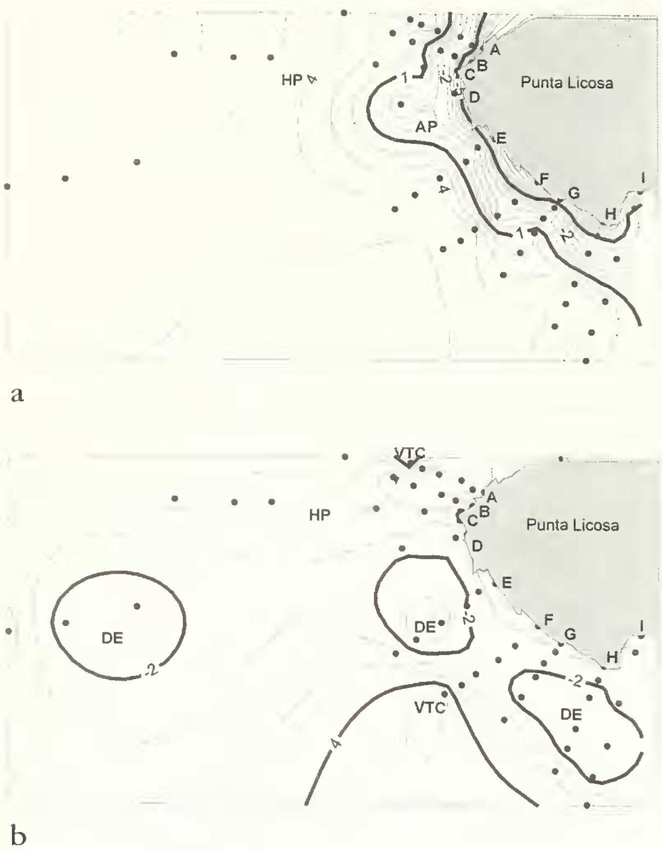

Figure 12. LICOSA, kriging maps: scores of bionomic descriptors on F1 (a) and on F3 (b).

ing a large rocky shoal. The deep zone (greater than 10 m depth), shows a more complex ecological physiognomy, which may be better investigated by taking into account environmental factors expressed by the other axes of the models.

The ordination along the second and third axes is mostly the expression of spatial patterns related to 'lateral' gradients. These gradients mark the coenotic discontinuities that exist between the different sectors of the marine reserve, aside from the depth-related effects. Also in this case, consistent information was obtained by utilizing different types of descriptors. Coenotic discontinuities are more evident when the deep stands are compared as almost all the shallow associations are related to algal cover. A rather complex mosaic of ecological units is displayed in the maps. Large *Posidonia* seagrass beds, with a mollusc community dominated by scraper-herbivores, alternate with detritic areas dominated by suspension feeders. Muddy bottoms characterize just a few, very deep stations.

An interesting relationship between geomorphological and coenotic patterns can be observed in the southernmost area of Vallone Alto, where the of the Licosa shoal is marked by a very strong coenotic gradient, characterized by a drastic change in the trophic specialization of the taxocoene, from suspension to deposit feeding. This functional characterization represents a well integrated information on the hydrodynamic regime and the related features of the site, as it marks a low energy environment with large depositional area.

In conclusion, consistent information on the main bionomic features, and on the related structural and functional patterns gathered for the area of the marine park of S. Maria di Castellabate shows how the analytical procedure adopted in the present paper may prove to be effective in the recovery of information from malacological lists resulting from the activity of collectors.

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